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Pulsed laser induced photoemission and its effects in plasma discharge

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Laser-induced photoemission of electrons offers opportunities to trigger and control plasmas and discharges. However, the underlying mechanisms and their effects on the resultant plasmas and discharges are not well characterized. Photoemission itself is a highly nonlinear process through mechanisms including multiphoton absorption, above threshold ionization, field enhanced hot electron emission, and optical field emission or tunneling, etc. The dominant process depends on the work function of the material, photon energy and associated optical fields, surface heating, background fields, etc. To characterize these effects, breakdown experiments are performed and interpreted using a 0D discharge model and a quantum model of photoemission. In the low-current regime considered, it is found that laser-induced photoemission is sufficiently de-coupled from space charge effects to be observable. The breakdown voltage is found to be lower with photoemission than without. When the applied voltage is insufficient for ion-induced secondary electron emission to sustain the plasma, laser driven photoemission can still create a breakdown where a sheath is formed. This photoemission induced plasma persists and decays on a much longer time scale (~10 μs) than the laser pulse length (30 ps). The effects of different applied voltages and laser intensities on the breakdown voltage and current waveforms are investigated.

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